

**Appendix 7. Best Practices in the Engagement of Ocean Scientists**  
**Work Session Summary**  
September 26-27, 2010

**Work Session Objectives**

- To identify common elements in COSEE Center engagement of scientists in broader impact activities
- To develop a portfolio of examples of COSEE broader impact activity models based on published literature
- To develop a foundation of COSEE best practices in the engagement of scientists, including frameworks, strategies, etc.
- To identify and discuss solutions to the challenges of engaging scientists in education and outreach activities
- To identify and discuss solutions to the challenges of recruiting and retaining scientists for COSEE Center activities
- To identify best practices in successful transfer of the scientists' expertise and resources to classroom and public audiences
- To identify post-program engagement strategies

**Work Session Participants**

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Ivar Babb	COSEE TEK
Patti Bourexie	COSEE Florida
Bob Chen	COSEE Ocean
Tansy Clay	COSEE OLC
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Pam DiBona	COSEE New England
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Janice McDonnell	COSEE Networked Ocean World
Diana Payne	COSEE TEK
Michelle Philips	National Network Evaluation
Lisa Rom	National Science Foundation
Shawn Rowe	COSEE Pacific Partnerships
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Eric Simms	COSEE California
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Representatives from each COSEE Center, the Central Coordinating Office, the National Evaluation Team, and the National Science Foundation participated in this two-day work session

focused on the Network's best practices in the engagement of ocean scientists in education and outreach. What follows is an executive summary of the discussions and outcomes.

### **Pre-Work Session Survey**

Prior to the work session, twelve COSEE Centers completed a survey focused on the best practices in the engagement of scientists in education and outreach activities. What follows here is a summary of key findings. Survey results can be found in the Appendix.

#### *Types of Programs*

Most Centers (10 out of 12) conduct multi-day, residential, face-to-face scientist engagement programs. These are followed closely (8 out of 12 Centers) by one-day, face-to-face programs. Over half the Centers are also conducting multi-day, non-residential programs and multi-day, face-to-face programs followed by online interactions. It is clear that a significant amount of time and resources are going into COSEE multi-day, residential, face-to-face engagement programs. It is imperative that the impacts of these programs be measured and their best practices described.

The survey data shows that 70% of the Centers engage between 3-6 scientists during multi-day, residential, face-to-face scientist engagement programs. The numbers of scientists engaged per cohort vary across Centers and types of programs. However, the majority of programs, across all the types of programs, engage between 3-6 scientists per cohort. The average number of contact hours per scientist within a program varies, with the majority of contact hours per program type being between 6-12 hours per scientist. Table 2 in the Survey Results (see Appendix) provides the results for the number of contact hours per program type per Center. Forty-nine percent of the programs provide 12 contact hours or less, and 68% of the programs provide 20 contact hours or less.

#### *Effective Practices*

Centers were asked to identify one of their broader impact activities or programs that they believe integrates best/effective practices in the engagement of scientists in education and outreach (as they have determined from the literature). Table 3 in the Survey Results (see Appendix) provides the PIs' short descriptions of these programs and their goals. The programs are diverse and offer an opportunity for future assessment of which models are most effective for engaging the scientists as well as the participants. All of the programs provide broader impact opportunities for the participating scientists. Scientists give presentations (both in person and over the Internet), teach courses, serve as instructors in educator professional development programs, provide research experiences for teachers, students, and the public, collaborate with educators on the development of education materials, and lead field exercises for teachers, students, and the public.

The scientists have opportunities to learn about, reflect on, and reconsider approaches for addressing broader impacts as part of their funded research. They are given training in communicating their research and addressing public audiences. Center results show that scientists participating in COSEE activities improve their skills in reaching out to the media, decision makers, k-12 populations, and the general public. In addition gains are beginning to be made in helping scientists reach out more effectively to broaden participation of underrepresented populations within the ocean sciences.

The survey identified key program elements for engaging scientists in education and outreach activities. It is important to prepare scientists to engage in broader impact activities. Ten out of the twelve COSEE Centers prepare scientists for the programs in a number of ways: 1.) scientists receive pre-program orientation that may include participant assessment information; 2.) scientists receive training in science education pedagogy (face-to-face); 3.) scientists receive on-line training and preparation, 4.) scientists contribute journal articles for participants; and 5.) scientists assist in the program development or design.

Equally important is the need for the scientists to come away from their participation in education and outreach activities having professionally benefitted themselves. The effective programs identified by the COSEE PIs provide scientists with training on effective and interactive instructional methods and tools; exposure to new curriculum materials that they can use with their own students; introduction to new assessment strategies; and training on delivering effective webinars.

Eleven of the twelve Centers engage scientists in post-program activities. These activities include the mentoring of program participants; visits to educators' classrooms and informal science education institutions; engagement in post-program online or virtual collaborations; and provision of their presentations as on-line resources. The Centers also provide various types of post-program support to scientists, including financial support to present at national and regional conferences, co-authorship of educational journal articles, and community engagement in on-line social networking environments. There are benefits to the scientists to remain members of the COSEE community. Through social networking sites, they can communicate with out like-minded colleagues and share their education and outreach experiences. By joining Center list-servs and blogs and receiving Center and Network newsletters, they can stay updated on ocean sciences education initiatives, new tools, and opportunities for further broader impact activities.

Center evaluations of the impacts on their scientist participants have shown that the scientists have a greater appreciation for "what teachers do" on a daily bases, and they are more aware of the importance of standards and testing. The scientists report a better understanding of the manner in which pre-college students and the public needs to have research relevance based on the analogy...."so why should I be interested in these findings and what do they do for me?"

When discussing the survey results during the work session, it became clear that it would be beneficial for COSEE to determine the outcomes that it desired to achieve in engaging scientists in education and outreach. One of the key components of COSEE's programs is that the number of contact hours scientists have with program participants (average of 6-12 hours per program or cohort and 68% of the programs provide 20 or more contact hours) is greater than other ocean sciences education programs where the scientist may be involved as a guest speaker for an hour and then leaves the program staff to run the program. Also the ratio of scientists to participants on average (3-6 scientists for 16-20 participants) is higher than most ocean sciences education programs.

### ***Review of Best Practices in Published Literature***

Small group discussions focused on what Centers has gleaned from published literature on the best practices in engaging scientists in broader impact activities. There is a consensus that there is a lack of peer-reviewed literature on this topic. The Appendix contains a list of related papers that the Centers have reviewed.

There is a theory base of literature on the topic of communities of practice (Wenger, 1998; Wenger, et al., 2002; and Lave and Wenger, 1991), activity theory (Engestroem, et al., 1999), and adult/adult team training (Bingham and Conner, 2010) that might be helpful to review by a broader range of Network members. Best practices from that literature as applied in COSEE related programming include:

- Make the process explicitly about professional development in communications for the scientists
- Involve graduate students at all levels
- Make the process explicitly about development of communities of practice for scientists and graduate students working with and being communicators
- Build in opportunities for pre- and post-reflection time
- Provide mentoring (as novices are becoming experts – from communities of practice literature) before all events
- Support programming with tools and practices for building communities of practice that might be virtual and distributed, especially among graduate students
- Be explicit about the program/event goals so that they can be co-formulated and shared
- Be explicit that the tools and techniques they are learning are evidence based
- Give opportunities to practice and get (unbiased) feedback and critique
- Make sure it is about sharing work with mutual benefit
- Help scientists and graduate student to understand the audience (especially when the audience is diverse) and provide evidence-based tips for communicating

From the literature reviewed prior to the work session, several key effective practice elements were identified during the small group discussions. These include:

- Support an environment of mutual respect between research and education communities
- Participants need to be made aware of cultural differences between their communities
- The spectrum between ‘scientists and educators’ should be considered as a continuum – not a ‘them and us’ mentality
- Measure and share the meaning of ‘effective’ scientist engagement and share impacts of program activities with the scientists post-program, provide evidence and artifacts (letters for portfolios)
- Engage scientists at all levels of development (graduate through veteran faculty), and also consider promoting the engagement of small groups of scientists (lab groups) in addition to individual scientists
- Help scientists understand why they are needed in the education process
- Consider the role and level of facilitation in engaging scientists
- Promote leadership by scientists in education and outreach

In several discussions, the concept of professional development for scientists was explored. The scientists should know that through COSEE activities they are engaged in their own professional

development, especially through pre-program training and the building of their communication skills.

It is important to understand the scientists' motivations for engaging in E&O activities so that their needs get met. Some scientists participate because they want to improve their overall communication skills. They may have a specific goal because they are going to present their research results, be socially motivated, be merely satisfying broader impact requirements on their grant, have children in the school they visit, or be satisfying an institutional requirement. Moving beyond an individual scientist's motivation, it is important to help them understand that they are needed in the education process and why.

Established scientists they might not see that they have a lot to learn by participating in E&O activities, but they are open to their graduate students learning. Seasoned scientists can be motivated by helping them to understand that they are part of the community of learners. Team based training is a good model to use for engaging scientists. It is used extensively in teacher professional development. Scientists need to be part of the process that identifies the goals and objectives for their professional development.

### ***Key Elements in COSEE Scientist Engagement in Education and Outreach***

Two group discussions focused on what Centers have found to be key elements in the engagement of ocean scientists in education and outreach. Group one focused on models of scientist participation and group two focused on strategies for recruiting and retaining scientists in the COSEE community.

#### ***Group One***

Models of scientist engagement are varied as seen from the pre-meeting survey results. The key elements of a model should be aligned with the program goals. Different kinds of products and structures are used across the Centers depending on the purposes. Audience types are also a key factor with some Centers providing experiences for adult learners, informal science audiences, K-12 educators, the general public, etc. Following up with participants in a longitudinal way to determine the impact of the program is important if the results of their efforts are to be given to the scientists.

On the lower rung of the "Ladder of Engagement", scientists just come and make a presentation (either face-to-face or over the Internet). The scientist may also provide their presentation as a resource to the participants that may or may not be posted on-line. Moving up the ladder, the scientist may give multiple lectures over a period of time, expansions to this may include opportunities for the audience to interact online with the scientists and can ask questions.

Currently, there is no formal mechanism for how successful models of scientist engagement get disseminated across the COSEE Network. Discussions and news, primarily through face-to-face meetings, monthly Council calls, and the Network newsletter are the primary means of Network communication. It would take additional resources to expand the opportunities for communication among Network members.

One model that has been seen as highly effective is COSEE Ocean Systems Concept Mapping Workshop for scientists and educators. The model has three phases: a collaboration phase; a peer

to peer phase, where scientists present science and then high school teachers provide feedback on how the scientists can improve their presentations; and a reconnection phase, where the scientists revisit the original concept maps and apply them to a new situation. This model is currently being expanded to include training for the scientists on how to blog effectively. In this model, both the scientists and teachers are also trained to use software that involves building the concept map. Once the maps are created and adjusted based on the teachers' feedback, they are posted on an interactive website, where pieces of one map can link to other ocean science concepts. Others can access the maps and adapt them for their own use. In this model the scientists clearly see the value of their participation, both to themselves and others.

The COSEE California Communicating Ocean Sciences Course is also an example of a successful scientist engagement model. It exposes the scientists, primarily graduate students, to learning theory and the nature of science. A key ingredient of this model is that the scientists are part of the course planning for the content that they will deliver. This course has been adopted by many COSEE Centers and other institutions across the country. COSEE Networked Ocean World (COSEE NOW) has adapted the course to reach 4H audiences. The COSEE CA team, in partnership with COSEE West and COSEE Pacific Partnerships (COSEE PP), has adapted the full 16-week course to train the 2011 national cadre of Knauss Fellows. The expansion and adaptation of this course has been made possible with additional Center funding from NOAA and NSF.

A discussion touched upon the challenge of determining what can be expected of scientists in these engagement activities. Some learning theorists may take issue with the idea that you can give scientists a digressive view of pedagogical theory and then expect them to successfully implement it. It is important to recognize that ocean scientists, who are participating in COSEE activities, be given the opportunity to practice and to try the strategies they have just learned, reflect on the experience, and self-determine what else they need to learn to be more effective.

### *Group Two*

Scientists are recruited in various ways across the Network, and in some cases this is institution specific. Most often a specific opportunity is first identified, and then scientists are recruited to participate in that program or event. Existing networks of scientists are seen as a valuable recruiting tool. At universities, departmental seminars and faculty meetings are good resources. However, recruitment is most successful when the scientist is familiar with the individual seeking their participation. Scientist to scientist engagement is very effective.

There is a continuum of engagement types. The first engagement may be small, a low investment on the part of the scientist. This continuum can grow from multiple engagements to the scientist independently conducting their own program or event.

This group discussed the importance of understanding the needs of scientists. For example, NSF-funded scientists' needs may be different from others because of the Criterion Two broader impact requirement. Scientists' needs that COSEE is addressing are the needs to:

- learn how to teach
- craft sound broader impact plans for their proposals
- give to their communities
- support graduate students

- training their graduate students to teach
- increased their capacity to communicate
- learn how to collaborate better with others
- develop strategies for citizen science programming
- reach a more diverse audience in recruiting students for ocean sciences careers.

Optimally, it is beneficial for Centers to retain ocean scientists as part of the COSEE community once they have participated in E&O activities. Engaged scientists might go on to other programs and continue to have impacts. The need to describe for scientists a “Ladder of Engagement” was discussed. This ladder would assist scientists in continuing to increase their capacity and become leaders in achieving broader impacts of their research.

### ***Key Elements in Recruiting Scientists from Underrepresented Populations and Preparing Scientists to Work with Diverse Audiences***

The ocean sciences present a challenge for increasing diversity. The biggest obstacle is that approximately only 6% of the graduating Ph.Ds. in ocean sciences over the last decade (based on NSF data) population are from groups underrepresented in science, engineering, and technology disciplines. The few individuals from this 6% that are accessible at academic institutions are well known to the COSEE community and are asked again and again to participate in E&O activities. Until the ocean sciences workforce is more diversified, recruiting ocean scientists from underrepresented groups presents an insurmountable challenge. This drives home the point that we must attract more students from these groups to ocean science careers.

There is a substantial body of literature that examines effective ways of reaching racially or culturally different groups. The COSEE community needs to become familiar with these strategies and then train participating scientists appropriately to interact with underrepresented groups. Centers have the ability to reach these groups through partnerships with school districts and undergraduate populations at partner institutions. Also some Centers, such as Central Gulf of Mexico, have high populations of educators from these groups.

Undergraduate and K-12 teachers and students are very important to target if Centers are going to successfully reach down the career force pipeline. COSEE could learn from other programs that have successfully reached underrepresented groups such as the Harvard Medical School Diversity Program. There are a few ocean sciences REU programs that focus on recruiting minority students (such as one at the University of Hawaii). It might be beneficial for COSEE to collaborate with these programs.

At the Network level, COSEE has been able to work with the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) to reach undergraduate and high school students. COSEE staff interact one-on-one with approximately 300 students each year at the annual SACNAS meeting. In addition, COSEE sponsors a panel on ocean sciences workforce opportunities with nationally recognized scientists. The number of student participants is growing each year. Most of the students reached at the SACNAS meeting don’t think of ocean sciences as a career possibility. They have never been exposed to the diverse number of ocean sciences related fields. Collaborations with professional societies are an excellent way of reaching underrepresented students who would otherwise not have access to ocean scientists.

COSEE Ocean Learning Community (OLC) has initiated a program for minority high school students from local school districts. The students participate in research where they are able to choose their own research questions and present their results. OLC is also providing culture sensitivity training to their GK-12 graduate students who are placed in highly diverse schools. These graduate students are also creating a science curriculum designed for social justice. These two programs may be models that could be adopted by other Centers. Funding for both of these programs is in addition to the Center funding

COSEE OS has recently brought the Institute for Broadening Participation into the Network as a key partner. This organization has a wealth of resources and experiences in broadening the participation of underrepresented groups in the sciences. This COSEE OS partnership may greatly benefit the Network.

Scientists are prepared to work with diverse audiences by several Centers. COSEE West and COSEE Pacific Partnerships uses K-12 teachers to help scientists understand the challenges. Several of the COSEE PIs stated that, as a community, COSEE Network members need cultural competence training before we can train scientists.

### ***Preparing Scientists to Interact with the Public, Educators, and Students***

Centers prepare scientists in a number of ways. Teasing out the “best practices” requires more evaluation on this program element. Models used currently include:

- the lunchbox model – taking a scientist to lunch or some other informal setting to share ideas and engage their interest;
- coordinating preparation efforts with academic departmental events (e.g., seminars)
- the webinar model – online preparation that is scalable, but maybe not the best initial approach since personal touch is important initially
- the peer-to-peer training model – leveraging scientists who have already demonstrated an interest and aptitude for E&O activities to be involved in preparation efforts of other scientists
- face-to-face training and provision of practical tools (e.g., resources on how to tell a story).

### ***Transferring Scientists’ Expertise and Resources to Classroom and Public Audiences***

The transference of scientific content and understanding to the intended audiences is an important goal for E&O programs. Centers are achieving this in a number of ways. Again, more evaluation is needed to determine what the “best practices” are in this area. The following strategies are currently being implemented across the Network:

- Briefing papers are written by scientists that are concise, accessible and easy to share with decision makers, media, etc.
- A wide variety of supporting content resources are being produced and delivered using technology including via online, through different types of media, over Skype, through YouTube, Facebook, Twitter, blogging, etc.
- Informal science exhibits are developed including casual, informal table top devices and games
- Curriculum is being co-developed by scientists and teachers.

New opportunities and vehicles for transfer were discussed including the use bus tours, cruise ships, restaurant table placements, and other tourist venues.



### ***Post-program Engagement Activities***

To encourage scientists to ascend the ladder of engagement in E&O activities, they must be engaged after their initial experience. Centers use multiple strategies for doing this. Evaluation results show that it is important to get feedback to the scientists as quickly and tangibly as possible. Some Centers survey their scientist participants over time to see how their experience is impacting their teaching or future broader impact activities.

The discussions suggested that scientists who have completed COSEE activities could serve as effective mentors for new scientist participants. This would help to develop an E&O leadership strand for scientists within COSEE. The discussions also centered on a way to use social media to further engage scientists. This is a challenge for older scientists who may not be comfortable with the impromptu nature of the communication. This might be a successful mechanism for reaching younger scientists, who are more likely to respond using social networking.

Scientists who have been engaged in E&O activities are encouraged to present results in E&O sessions at professional society meetings. COSEE has held many of these sessions over the last three years at 10 different science society meetings and 5 education society meetings. However, a significant obstacle is that many societies only allow one abstract per presenter. So if a scientist is presenting his or her research, they can't be the lead on an E&O related abstract.

Many Centers are actively engaged in assisting scientists at their institutions with crafting their proposals' broader impact plans. It is important to follow up with these scientists to determine the fate of these plans - did this part of the proposal get funded? Do the scientists need resources or training for implementation?

### ***COSEE Scientist Survey***

In 2010 the COSEE Center evaluators identified 749 ocean scientists that had worked with COSEE during 2009. These scientists were invited to take an on-line survey. Of the total number invited 487 individuals responded. The evaluators culled this list to what they call "the platinum group" - 315 currently practicing scientists and engineers. One issue that contributed to the difference between the 487 respondents and the platinum group was that approximately 100 respondents did not complete the survey. Therefore, they didn't make platinum. The platinum group represents 32 states and 46% receive NSF funding. These respondents nearly equally represented the ocean sciences career span (28% early career, 32% mid-career, and 25% advanced career stages). The breakdown of degree attainment was 71% Ph.D. and 18% M.S., and there were 45% females and 55% males. The racial breakdown was 89% Caucasian, 4% Asian, and 1% African American. Of this group, 78% are also engaged in teaching. This survey is being refined and is being administered again in 2011 for scientists who participated in COSEE activities during 2010. These data are assisting COSEE in understanding the group of ocean scientists that is being reached.

### ***Mentoring Strategies: COSEE Staff Mentoring Scientists***

Mentoring is an important element of E&O activities. Discussions were held that focused on three types of mentoring. COSEE staff mentor scientists that become engaged in COSEE activities. The scientists are provided guidance about the attributes of the audience they will face, including what the audience's needs might be. This guidance is not very effective if it is a "one shot" approach. COSEE Central Gulf of Mexico (COSEE CGM) engages their participating

scientists one-on-one and over multiple encounters. Although this is time consuming, it is paying off as their evaluation results show that the scientists are staying longer at the events than required. These scientists are also involved in question/content development and help the Center staff to formulate good test and measurement strategies.

COSEE NOW provides mentoring to scientists by outlining the Ocean Literacy Essential Principles and the curriculum ahead of time. Their scientists also go through the process of explaining their science to a curriculum developer who provided feedback on how these concepts might fit into traditional science curricula.

COSEE PP introduces their scientists to communications theory, including the research basis. As with many Centers, COSEE PP also provides their participating scientists guidance on how to make effective PowerPoint presentations and poster sessions. Graduate students are particularly eager to learn more about this topic. True mentoring comes from interactions over time.

One obstacle to this type of mentoring is that there appears to be the general sense that “anyone can do outreach” and that scientists don’t need more training. Use of rubrics for the scientists that are straightforward and not “personal” can be very effective. The immediate unbiased feedback on their presentations or instruction can help them improve their practice.

COSEE should look to experts and the research base on mentoring. The Centers have empirical evidence that they’re doing a good job, but may not be really engaging in mentoring “best practices.”

### ***Mentoring Strategies Between Scientists Mentoring Educators***

For the mentoring of educators by scientists or of scientists by educators to be effective, egalitarian attitudes must be fostered at the outset. Informal interaction time is needed to build the relationship and trust between the parties. Both groups need to know and understand the others’ needs. The Centers should provide a mechanism for the two groups to explore different ways of thinking and communicating and establishing a way of working together.

While scientists may learn pedagogy by working with educators and educators may learn science content, they are not necessarily becoming part of each other’s communities. Effective mentoring happens as a part of partnerships. Opportunities should be provided for scientists and educators to spend time each other’s environments. The fostering and supporting of long term relationships requires explicit expectations.

### ***Overcoming Obstacles and Contributing to the Field***

For COSEE to identify and further embrace the most effective strategies for engaging ocean scientists in education and outreach, the Network must overcome current obstacles. Also it is important for the Network to communicate what it is learning to other professionals in the field.

The biggest obstacles to engaging scientists are the common ones found in most endeavors: time, money, and energy/resources. These three obstacles affect the scientists themselves as well as Center staff. The Centers must be sensitive to the obstacles facing the modern ocean scientist, who has multiple demands on his/her time. Scientists must be reached on their time scale and in the places where they can be found such as their office or laboratory. Centers must be flexible

and have multiple ways for scientists to contribute. Once scientists gain more experience in E&O, they will trust the process and rise up the ladder of engagement.

Centers need to publish about the lessons they are learning and the methods they are using. However, to publish in traditional education journals, resources need to be found to allow for educational research and deeper evaluation studies. Another obstacle is that currently, there are no journals focused on education and outreach. Some strides have been made through COSEE publications in education journals, including journals related to geosciences and environmental education.

As the National COSEE Network moves forward, we must identify our internal metrics and outcomes for engaging scientists in education and outreach activities. However, it is also important for NSF to provide guidance on the goals they have for broader impact activities. During the 2010 Evaluators' Workshop, the evaluators discussed the need for data on COSEE's impacts on ocean scientists. The evaluators group has refined its scientist survey for 2011 and will begin to collect data Network-wide that will help the Network to better gauge these impacts. There is a general sense that COSEE is helping to change the ocean sciences culture in that scientists' attitudes are changing about their role in E&O. It would be very helpful for the Network and NSF if this could be quantified.

### ***Collaborations and Partnerships***

At the Center level scientist engagement activities are very effective. At the Network level, we've just begun to explore models and methods. Several Centers have been successful at establishing partnerships to support their engagement activities. COSEE CGM has partnered with the Gulf of Mexico Alliance. The content that their scientists deliver each year is related to the Alliance's priority issue themes. The Center uses the Alliance for scientist recruitment and helping to determine the ocean science important in their region. Another key CGM partnership is the Gulf of Mexico Coastal Observing System Network. Over half of the Centers have formal relationships with their regional Coastal Ocean Observing Network.

COSEE is connected to several other national networks through which it is connected to the broader ocean sciences education landscape. For example, each Center has a formal partnership with their local Sea Grant offices, and several Centers have partners affiliated with the 24 Coastal Ecosystem Learning Centers.

Several major U.S. school districts are formal Center partners, including the Los Angeles Unified School District (COSEE West) and the San Diego Unified School District (COSEE CA). Close to half of the Centers also have partnerships with a YMCA and/or a Boys and Girls Club.

The list of Center and Network partners is extensive and growing. The data collection currently underway for COSEE's Decadal Review will help us identify all the partners at all the Centers. This will help the Network to see how connected COSEE is to other networks and organizations. All these partnerships provide opportunities for engaging ocean scientists with groups far beyond the scope of their traditional reach.

### ***Summary***

The last task for the work session participants was to describe an ideal scientist engagement program that utilized the most effective practices that had been discussed during the meeting. The participants were tasked with identifying the purpose of this ideal program, outlining its objectives and desired outcomes, and including the necessary stakeholders.

Here are some of the recommendations from this exercise:

- Conduct periodic needs assessments to help understand the audiences
- Use evidence based information to inform the project's design
- Include participating scientists in project design, and the design should allow for post-program engagement
- The program's design should build on prior Center experience so that it becomes part of you're the Centers own learning cycle.
- The design should include a means for help the participants improve their own practice.
- When multiple scientists are participating, they should have a range of experience
- All benefits of participation should be articulated
- Set up cohorts of participants to build communities of practice and provide them with a means of communicating with each other over time
- Give the participants an orientation that covers the Center, its goals, the goals of the specific program, and evaluation expectations
- Provide time and a mechanism for establishing peer to peer relationships, allowing all participants to share the expertise that they bring
- Provide feedback to the participants that they can have for their own records
- Provide an opportunity to debrief in person
- Help scientists make connections between their research and the Ocean Literacy Essential Principles
- Provide opportunities for mentoring
- Get feedback and critique, build in reflection time
- Track how scientists use what they have experienced

The participants identified several concepts that would help to make COSEE engagement programs more effective. As the Network moves forward, the concept of the ladder of engagement should be further explored. This could be a helpful tool whereby a scientist could choose his or her own entry point and how far they wished to climb.

Further engagement of the learning sciences community will provide more evidence-based information on which to design scientist engagement programs. The literature on building communities of practice could assist COSEE in the future. Developing a community and providing a means for the community to have peer-to-peer interactions may be key in retaining scientists in the Network.

Recruiting scientists through partnerships with other networks is a valuable means of growing the Network and reaching beyond our own partner institutions. This will also assist the Network in diversifying its audiences. It may also be beneficial to collaborate and partner with groups outside of the ocean sciences to help us improve our methods.

COSEE must remain innovative and transformative to have continued success. The Network must identify its innovative and transformative elements and provide the appropriate evidence of

its success. This is a common challenge for many organizations that are involved in the engagement of scientists in education and outreach. It would be beneficial for COSEE to host a meeting of diverse groups representing different stakeholders and disciplines that could explore the challenges discussed herein, including determining impacts on the scientific community, identification of best practices, publication issues, and potential partnerships and collaborations.

## APPENDIX

A. Work Session Agenda

B. Pre-Meeting Survey Summary

C. References Contributed by Participants

## Appendix A

### **Best Practices in the Engagement of Scientists in Education and Outreach September 23-25, 2010 URI, Graduate School of Oceanography *Work Session Agenda***

#### **Thursday, September 23**

6:30 pm	Pick-up at Hampton Inn
7:00 pm	DINNER, TBD

#### **Friday, September 24**

8:15 am	Pick-up at Hampton Inn
8:30 am	Arrive at Graduate School of Oceanography
8:35 am	Overview of objectives, NSF Perspectives
8:50 am	Summary of Center survey results
9:45 am	Summary of the evaluators' discussions concerning scientist engagement
10:30 am	BREAK
10:45 am	Review of best practices from the literature (small group discussions)
11:45 am	Summary of literature discussions (large group)
12:15 pm	LUNCH
1:00 pm	Key Elements (1) in COSEE scientist engagement in education & outreach (small group discussions) - Group 1: Models of scientist participation in broader impact activities - Group 2: Strategies for recruiting and retaining scientists in the COSEE community
2:10 pm	Summary of Key Elements (1) discussions (large group)
2:40 pm	BREAK
3:10 pm	Key Elements (2) in COSEE scientist engagement in education & outreach (large group discussions) Recruiting scientists from underrepresented populations and preparing scientists to work with diverse audiences
3:40 pm	Key Elements (3) in COSEE scientist engagement in education & outreach (small group discussions) - Group 1: Models for preparing scientists to interact with the public , educators, and students - Group 2: Successful models for transferring the scientists' expertise and resources to classroom and public audiences - Group 3: Successful post-program engagement activities
4:50 pm	Summary of Key Elements (2) discussions (large group)
5:30 pm	Adjourn
6:00 pm	DINNER, TBD

**Saturday, September 25**

8:15 am	Pick-up at Hampton Inn
8:30 am	Arrive at Graduate School of Oceanography
8:35 am	Preparing for the Decadal Review - Metrics for the successful engagement of scientists in broader impact activities
9:20 am	Mentoring strategies (small group discussions) <ul style="list-style-type: none"><li>- Group 1: COSEE staff mentoring scientists</li><li>- Group 2: Scientists mentoring educators</li></ul>
10:20 am	BREAK
10:35 am	Summary of mentoring discussions
11:05 am	Overcoming obstacles and contributing to the field (small group discussions) <ul style="list-style-type: none"><li>- Group 1: Issues, challenges, and solutions</li><li>- Group 2: Impacts</li><li>- Group 3: Collaborations and partnerships</li></ul>
12:00 pm	Summary of overcoming obstacles and contributing to the field discussions (large group)
12:30 pm	LUNCH
1:15 pm	The best of the best - exemplary COSEE scientist engagement models based on literature and evaluation results; identification of examples to be included in a COSEE Network portfolio (large group)
2:15 pm	Future directions for COSEE's engagement of scientists (large group)
3:00 pm	ADJOURN



## Appendix B

### COSEE Center Best Practices in the Engagement of Scientists in Education and Outreach Survey Summary September 2010

Twelve COSEE Centers completed this survey prior to a two-day work session focused on the best practices in the engagement of scientists in education and outreach activities. What follows here is a summary of survey results and analysis of key findings.

Most Centers (10 out of 12) conduct multi-day, residential, face-to-face engagement programs. These are followed closely (8 out of 12 Centers) by one-day, face-to-face programs. Over half the Centers are also conducting multi-day, non-residential programs and multi-day, face-to-face programs followed by online interactions. It is clear that a significant amount of time and resources are going into COSEE multi-day, residential, face-to-face engagement programs. It is imperative that the impacts of these programs be measured and their best practices described.

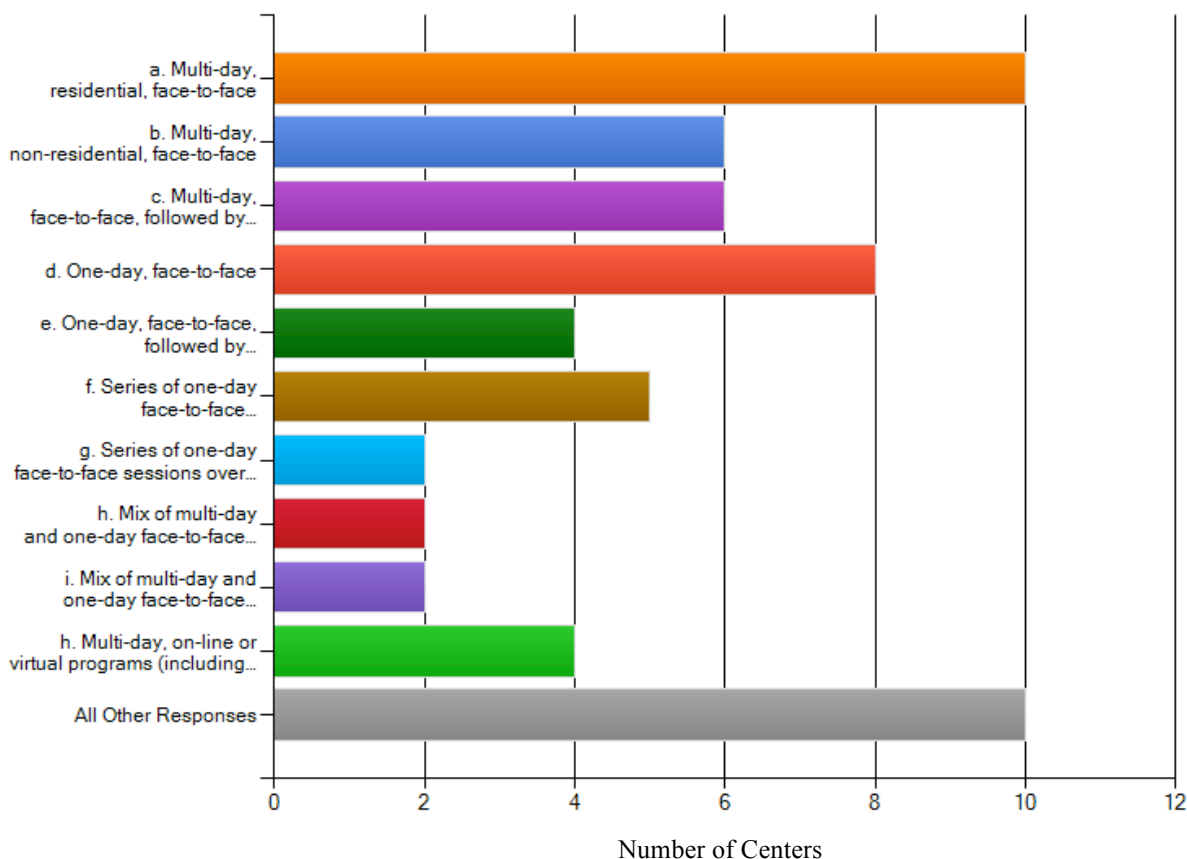


Figure 1. Types of COSEE Scientist Engagement Programs

Survey comments on other types of engagement activities:

1. Two, annual, multi-day, on-line sessions, following the multi-day, residential, face to face session; and two annual, two-day, face to face sessions
2. We have brought different cohorts together for one-day, face-to-face sessions, under different projects: youth mentoring program (3 scientists, 4 hours training + school-year mentoring program); Telling Your Story training workshops (>16 scientists, 8 contact hours, 1-day program); Regional Ocean Literacy Summit (>16 scientists, 8 contact hours, one-day program)
3. Scientists use our tools for teaching their own courses.
4. PRIME program is an internship for community college students working with a scientist for 8 weeks
5. Multimedia podcasts and videos with scientists

As mentioned above, multi-day, residential, face-to-face engagement programs comprise the highest percentage of scientist engagement programs and they are offered by 10 of the 11 Centers. The survey data shows that 70% of the Centers engage between **3-6 scientists** during these programs. The numbers of scientists engaged per cohort vary across Centers and types of programs. The majority of programs, across all the types of programs, engage between **3-6 scientists**. A significant number of scientists are also engaged in single day, face-to-face and multi-day commuter programs as seen in the data in Table 1 below.

Table 1: Average number of scientists engaged per cohort per Center

Program Type	Ave. No. Scientists per Cohort/ No. Centers				
	1-2	3-6	7-10	11-15	>16
Multi-day, residential		7	1	2	
Multi-day, commuter		4		1	2
Multi-day, face-to-face, followed by online		4		1	1
Single day, face-to-face	4	1			3
Single day, face-to-face, followed by online		2		1	
Series of one-day, face-to-face sessions over time	1			3	
Series of one-day, face-to-face sessions over time with on-line interactions	1		1	1	
Mix of multi-day and one-day face-to-face sessions over time		1	1	1	
Mix of multi-day and one-day face-to-face sessions over time with on-line interactions			2		
Multi-day, on-line		1	1		
One-day or one time, on-line	1	2	1		1
Graduate course	1	3			1
Certificate program		1			
Other		2	2		

The average number of contact hours per scientist within a program varies, with the majority of contact hours per program type being between 6-12 hours per scientist. Table 2 provides the results for the number of contact hours per program type per Center. Forty-nine percent of the programs provide 12 contact hours or less, and 68% of the programs provide 20 contact hours or less.

Table 2: Number of contact hours per program type per Center

Program Type	Ave. No. Scientists per Cohort/ No. Centers						
	<5	6-12	13-20	21-30	31-50	51-75	>75
Multi-day, residential	2	3	2	1	1		1
Multi-day, commuter			4	2		1	
Multi-day, face-to-face, followed by online		2	2	3			
Single day, face-to-face	4	4					
Single day, face-to-face, followed by online		3					
Series of one-day, face-to-face sessions over time	3	1		1			
Series of one-day, face-to-face sessions over time with on-line interactions			1		1		
Mix of multi-day and one-day face-to-face sessions over time		2	1				
Mix of multi-day and one-day face-to-face sessions over time with on-line interactions					1		1
Multi-day, on-line		1	1				

One-day or one time, on-line	5						
Graduate course			1	1	1	1	1
Certificate program					1		
Other	1	1					2
<b>TOTAL Center Programs</b>	<b>14</b>	<b>17</b>	12	8	5	2	5

Centers were asked to identify one of their broader impact activities or programs that they believe integrates best/effective practices in the engagement of scientists in education and outreach (as they have determined from the literature). Table 3 provides the PIs short descriptions of these programs and their goals.

Table 3: Programs that exemplify best practices in the engagement of scientists in education and outreach

<b>Center</b>	<b>Scientist Engagement Program</b>	<b>Program Goals</b>
COSEE Alaska	Communicating Ocean Science Workshop at the Alaska Marine Science Symposium; one-day, face-to-face with online follow-up and web posting	A series of presentations by scientists and educators for scientists showcasing experiences and models for achieving broader impacts- networking scientists, educators and communicators.
COSEE California	Communicating Ocean Sciences College Courses, Series of one day, face-to-face sessions with online interactions; Communicating Ocean Sciences Instructors Workshops, Multi-day face-to-face followed by online interactions	Goals of the Course To introduce diverse future scientists to the importance of K-12 education, public outreach and the "Broader Impact" of their work in ocean sciences; To introduce diverse students in science degree programs to possible careers in education and teaching; To encourage thoughtful, mutually beneficial collaborations between ocean scientists and educators co-teaching the course; To provide significant ocean sciences instruction and college-age role models for under-represented K-12 students.
COSEE Central Gulf of Mexico	Multi-day, face to face followed by on-line interactions such as the Summer Teacher/Scientist Institute	We want the formal and informal educators engaged with the ocean sciences researchers so they both leave our Summer Institutes with a mutual respect for each others' professions, i.e., the educators will have enhanced content knowledge concerning the relevance of the world's ocean, its coasts and watersheds and the ocean sciences researchers will have a better understanding of "how" children learn, an increased appreciation of pedagogy (instructional skills), and an augmented awareness of state and national standards.
COSEE Coastal Trends	The Scientist-Educator Partnership Program; multi-day face to face, online interactions	Six week research experience which teams a scientist, graduate student, teacher, and underrepresented undergraduate student to work together to enhance scientists communication skills and teacher/student knowledge in scientific research.
COSEE Great Lakes	Shipboard and Shoreline Science; multi-day face-to-face; residential aboard research vessel	<ul style="list-style-type: none"> <li>engage educators in actual science research being conducted on the Great Lakes</li> <li>* assist scientists in communicating with educators about needs of science and education</li> </ul>

		* Give scientists opportunity to lead investigations with educators from hypothesis to data collection to analysis & conclusions
COSEE New England	Summer Science in New England, multi-day face-to-face residential and one-day face-to-face sessions over time followed by online interactions	Increase teens' awareness of Ocean and Climate Literacy Principles. Increase ocean- and climate-science grounding of summer camp programs for teens. Increase ocean scientists' input to informal education. Increase regional capacity for cross-region information sharing and collaboration.
COSEE Networked Ocean World	Marine Activities Resources & Education (MARE) training	4 day training, followed by 1 day training, followed by online learning, followed by 1 day face to face program.
COSEE Ocean Learning Communities	Addressing Broader Impacts Requirements workshop; Multi-day face to face commuter workshop (2 days long)	For scientists to learn about, reflect on, and reconsider approaches for addressing broader impacts as part of NSF-funded proposals. Specifically, to 1) show scientists how to frame broader impacts activities so their proposals stand out; 2) improve skills for reaching out to media, decision makers, k-12 populations, and the general public; or 3) show how to reach out and broaden participation of underrepresented populations within the ocean sciences.
COSEE Ocean Systems	Scientist-Educator Collaborative (SEC) workshops & Research-based Online Learning Event (ROLE) model webinars; multi-day, face-to-face followed by on-line interactions	SEC workshops follow a "peer-to-peer" model of interaction between educators and scientists. In this model, scientists and educators are considered to be on level ground with each group being "expert" in their own area. It is key that both groups believe they have something to learn from each other, and this leads to a mutually beneficial collaboration. Scientists contribute rigorous content knowledge and educators likewise contribute rigorous pedagogical expertise about the needs of different audiences. Using Ocean and Climate Literacy Principles as a "match-making" framework, scientist-educator teams develop online concept maps that are responsive to the needs of non-scientist audiences. Afterwards, select scientists are invited to give webinar presentations that include live "Q&A" sessions. The ROLE model webinars extend the reach of scientist-created concept maps to new contexts, both geographically and topically (e.g., oil spill), with a relatively small investment of time.
COSEE Pacific Partnerships	Community College Faculty Workshops, Multi-day, face to face	Each summer, COSEE-Pacific Partnerships offers week-long professional development institutes for community college faculty at our partners marine stations. Each day focuses on a specific ocean science topic and includes a presentation by scientists who study the topic and curriculum materials, including lab exercises and field activities. The goal is to increase the inclusion of current marine science topics in community college curricula.

COSEE SouthEast	Sea Seekers: Students and Scientist in the field	To create a pathway between HBCU undergraduates with rural mostly black middle school students and with NOAA, NSF and University scientists with a focus on estuaries and investigation processes.
COSEE West	Online workshops, multi-day online interactions	Increase engagement of scientists and educators; deliver current ocean sciences research, resources, and ways that educators can implement in their educational settings; reach a greater number of participants through online dissemination of information; provide online resources for educators to use outside of the online workshops

There are key program elements for engaging scientists in education and outreach activities. The following survey summary data is related to the exemplary scientist engagement programs listed in Table 3. Figure 2 illustrates how these key elements are being incorporated into Center programs. Ten out of twelve Centers engage scientists in providing ocean sciences content instruction to educators. Seven out of twelve Centers engage scientists in leading field exercises for educators. At least four Centers are currently working with scientists to engage teachers in ocean sciences research.

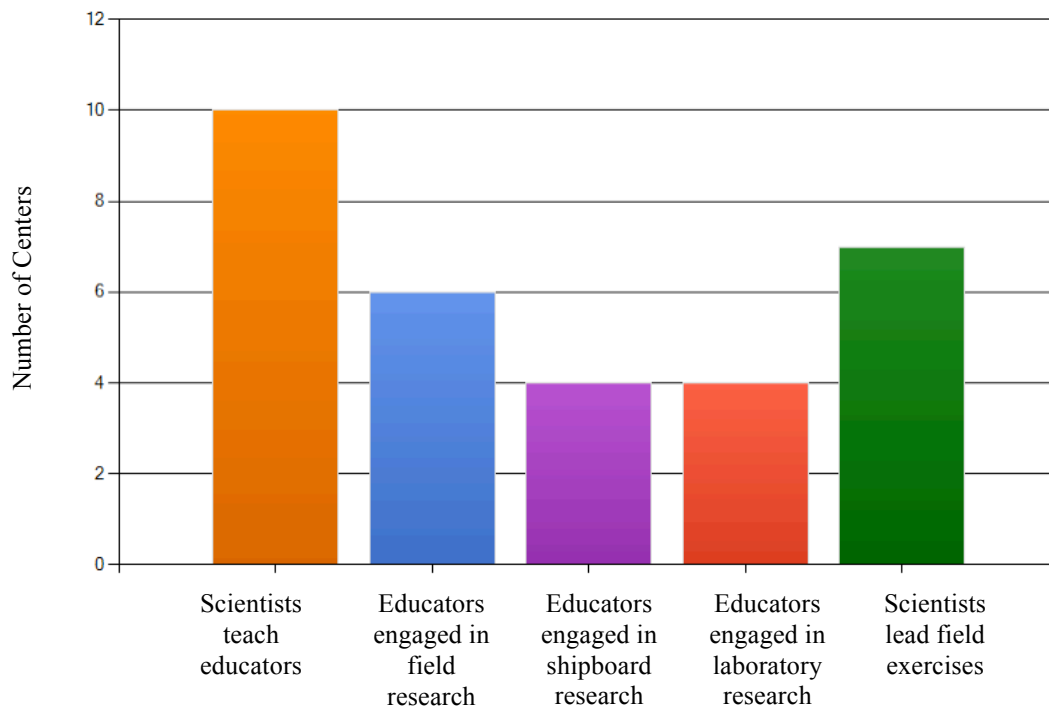


Figure 2: Key Scientist Engagement Program Elements

It is important to prepare scientists to engage in broader impact activities. Ten out of the twelve COSEE Centers prepare scientists for the programs listed in Table 3 in a number of ways. Figure 3 illustrates the elements these preparation activities.

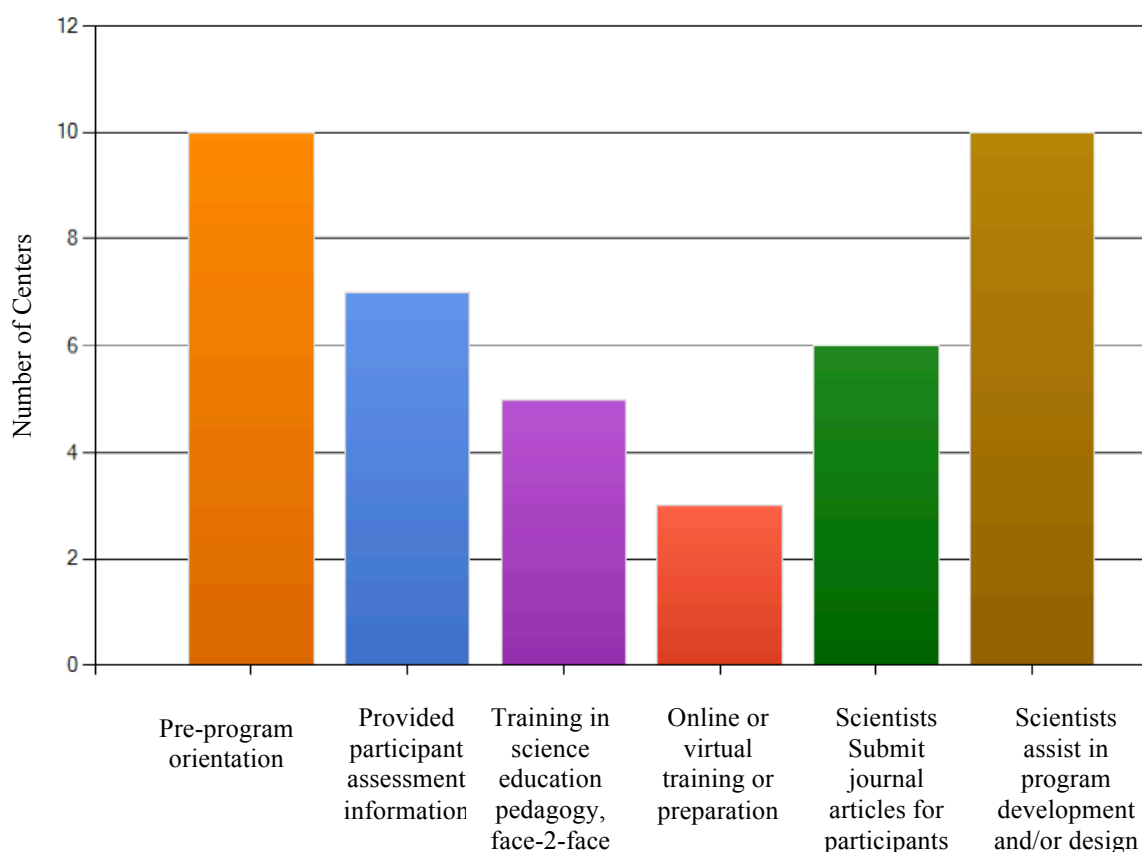


Figure 3: Pre-program scientist preparation

The nine of the Centers provide preparation for their scientist participants. They were asked to describe this preparation in more detail. Once Center's (OLC) program is geared specifically for the scientists themselves. So it does not necessitate preparation. Table 4 provides a description of the scientists' preparation as it relates to the exemplary programs delineated in Table 3 and repeated in Table 4.

Table 4: Ways in which scientists are prepared to engage in broader impact activities.

Center	Scientist Engagement Program	Scientist Preparation
COSEE Alaska	Communicating Ocean Science Workshop at the Alaska Marine Science Symposium	Discuss audience and effective and interactive methods and best practices
COSEE California	Communicating Ocean Sciences College Courses	Scientists participate in a 2.5 day COS Instructors Workshop in which they experience several of the course sessions; are introduced to the course materials, approach, and evaluation findings; and are provided with structure time for planning their own implementation of the course for under-represented K-12 students.
COSEE Central Gulf of Mexico	Summer Teacher/Scientist Institute	Scientists are invited to participate in our Summer Institutes (face to face and online), as well as the Two-Day Workshops by the PI and Co-Investigators, therefore, they have a "good" understanding of the manner in which the Workshops/Institutes will be

		implemented and what their engagement role will be. The scientists also develop essay questions and pre- and post-test, multiple choice questions--based on their research content.
COSEE Coastal Trends	The Scientist-Educator Partnership Program	Scientists receive a Partnership Users Guide that details the program, and our staff communicate verbally all expectations.
COSEE Great Lakes	Shipboard and Shoreline Science	We do not work with the shipboard scientists specifically in advance of this event. We often select them for what we know of their ability to communicate clearly to the public, and for their interest in working with educators. With the number of events we coordinate each year, we provide as much individual attention to scientists as we can.
COSEE New England	Summer Science in New England	A multi-day, residential training workshop provided side-by-side training for camp educators and partner scientists to develop processes to be used in the following summer.
COSEE Networked Ocean World	Marine Activities Resources & Education (MARE) training	One on one discussion and training about the program/program goals. Review of Ready Set Science pedagogy. Goal is to help scientists develop classroom and field experiences that match 4 strands.
COSEE Ocean Learning Communities	Addressing Broader Impacts Requirements workshop	N/A due to the nature of our program, which was aimed at supporting scientists in their own outreach endeavors, rather than plugging them into a program targeting educators.
COSEE Ocean Systems	Scientist-Educator Collaborative (SEC) workshops & Research-based Online Learning Event (ROLE) model webinars	Prior to the arrival of educators for SEC workshops, scientists receive a half-day training session on concept mapping, presenting concept maps, and COSEE-OS software. In preparation for ROLE model webinars, scientists receive training on online presentation of concept maps (including use of WebEx software).
COSEE Pacific Partnerships	Community College Faculty Workshops	Each summer, COSEE-Pacific Partnerships offers week-long professional development institutes for community college faculty at our partners marine stations. Each day focuses on a specific ocean science topic and includes a presentation by scientists who study the topic and curriculum materials, including lab exercises and field activities. The goal is to increase the inclusion of current marine science topics in community college curricula.
COSEE SouthEast	Sea Seekers: Students and Scientist in the field	Team meetings at the Hollings Marine Laboratory with scientists and COSEE SE educators. SCSU science education faculty reviewed the scientists' materials for the middle grade lessons.

Eleven of the twelve Centers engage scientists in post-program activities. Ten of the Centers require scientists to provide their PPTs as a future resource. Seven of the Centers engage scientists in post-program online or virtual interactions. Figure 4 illustrates these activities

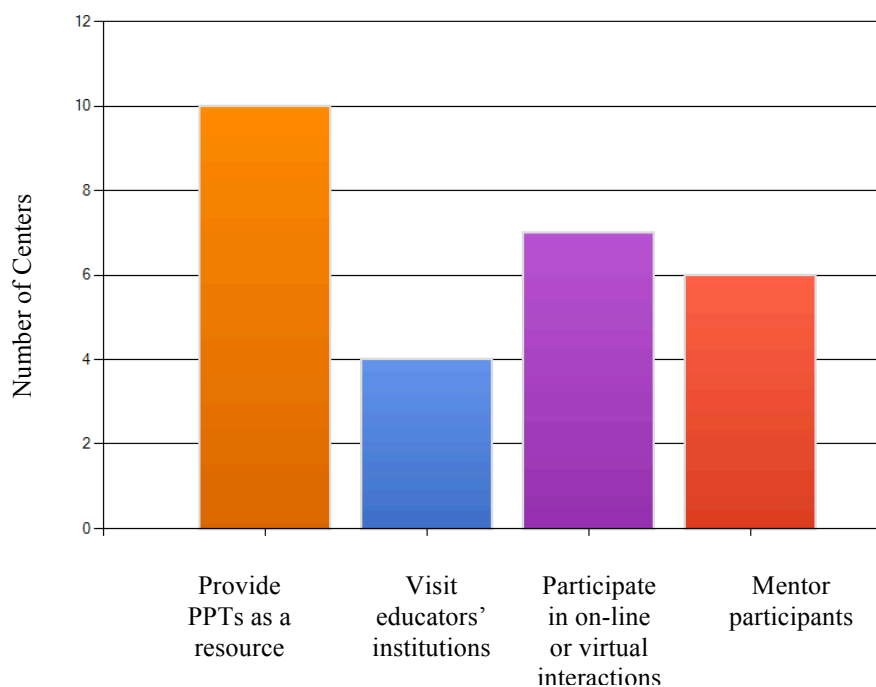


Figure 4: Post-program scientist activities

Individual Centers reported engaging scientists in other post-program activities are as follows:

1. Select numbers of scientists "stay in contact" with the teachers with whom they helped develop a lesson plan via e-mail.
2. Scientists are the instructors of the semester (or quarter) long course. They interact with their students face-to-face and online, and supervise their students practicum placements. They often maintain relationships with these students over time, helping them find related internships and/or writing them letters of support.
3. In this project, the educators and scientists are more partners than either one being the primary learner. Each is expected to bring an expertise to the table.
4. Scientists are willing to engage with the community college faculty via email for follow up questions/ideas for curriculum.
5. Scientists and graduate students return each year with a growing following for this workshop.
6. Scientists continue to converse with colleagues about their experience at the workshop, forge new outreach collaborations with other scientists they learned had similar interests in types of outreach at the workshop, and scientists seek additional consultation from COSEE-OLC in the preparation and submission of outreach components of research proposals.
7. Scientists made the equipment and COSEE SE provided the transport of organisms between HML and Orangeburg so students had live animals.



Centers provide various types of support to scientists for their broader impact activities following the program as seen in Figure 5 below. In most cases Center staff provide direct support, in some cases the scientists are also financially supported.

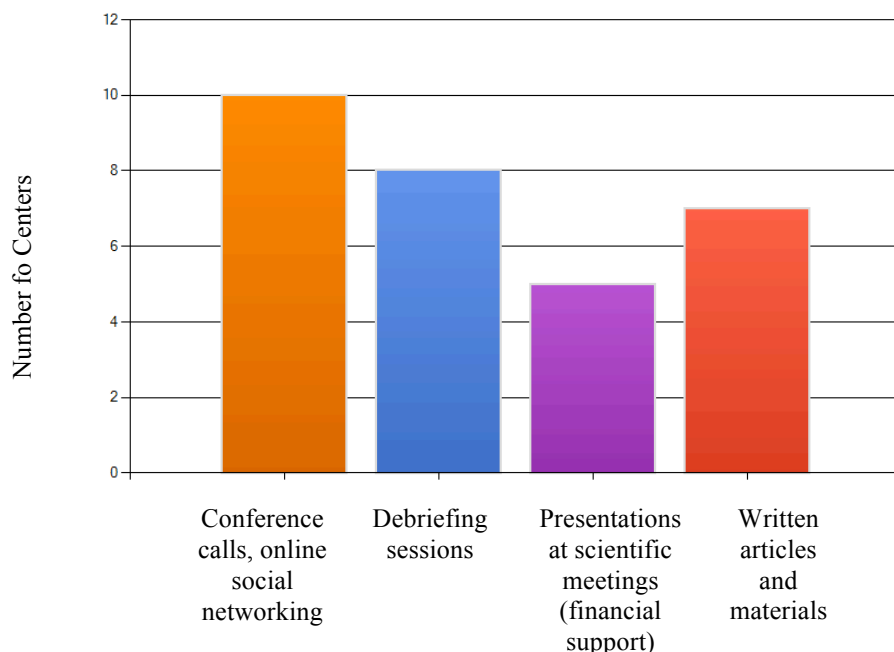


Figure 5: Center support for post-program activities

Individual Centers reported that they provide scientists with post-program support in other ways as follows:

1. COSEE CGOM staff members meet with scientists via e-mail to debrief and at state and regional meetings.
2. All COS Instructors become part of the COSIA Network (funded by NSF ISE). Many have become involved in other COSEE education/outreach efforts such as the Ocean Literacy Campaign and the Ocean Sciences Curriculum Sequence.
3. Center staff recruit scientists for future program participation in lectures, workshops, multi-day workshops, or one-day public events (Climate Day) based on their expertise in specific topics
4. Provide evaluations from faculty to the scientists
5. Center staff debriefed with scientists via on-line survey; Center staff provide ongoing support to scientists engaging in E&O activities; Center staff plan additional events to continue to support scientists in further developing their capacity in the area of E&O.
6. COSEE SE provided funds for science educator to review and revise materials for online access of lessons. COSEE SE sponsored the teacher and evaluator to present at national conferences (NSTA and ASTE)
7. We include them in center-wide communications [newsletters, website news]. Evaluation follow-up solicits information on gains, needs, high and low points of interactions, suggestions.

The Centers were asked if the participating scientists were required to develop education materials as part of their engagement. Fifty percent of the Centers said they do have this requirement, and 50% said they do not require scientists to develop materials. Individual Centers described this activity as follows:

1. They help create our education modules as part of the Scientist Educator team.
2. The scientists work with the educators in producing and/or revising lesson plans and align them with the NSES and the OLEP&FCs....and, link them to the state standards.
3. They write lessons/activities that work in the field/classroom that educators can use.
4. Many scientists adapt or revise or customize the course materials, but this is not required.
5. Scientists are required to develop a series of concept maps, including a shareable online version that is hyperlinked to “assets” (i.e., images, videos, news) in the COSEE-OS database.
6. PowerPoint presentations, handouts, ideas for teaching are developed.

7. Scientists and COSEE SE educators worked together as a team.

Table 5: The Programs' benefits to the scientists

Center	Scientist Engagement Program	Program Benefits
COSEE Alaska	Communicating Ocean Science Workshop at the Alaska Marine Science Symposium	They are showcasing their broader impacts work to other scientists and engaging in discussions with educators; gaining insights and other tools by listening to others scientists and educators. Builds a network.
COSEE California	Communicating Ocean Sciences College Courses; Communicating Ocean Sciences Instructors Workshops	Helps them to become better teachers and communicators themselves; allows them to try out pedagogical approaches that they can then apply to their other classes; helps them to diversify the students in their programs by attracting diverse students into the major through the course; in some cases scientists report that teaching the course influences how they think about and conduct their own research; attracts undergraduates to become research assistants in the labs of the scientists; helps scientists to write better Broader Impact Statements because of their increased understanding of effective E/O practices; brings more attention to scientists and raises the profile of their work.
COSEE Central Gulf of Mexico	Summer Teacher/Scientist Institute	Benefits include: providing an opportunity for broader societal impacts; empowering the scientists to "feel more comfortable" with standards and pedagogy; allowing the scientists adequate time for discussions relative to "how" children learn; and affirming the need for scientists to explain their research findings in terminology people can better understand than when scientists are discussing these findings with their professional colleagues.
COSEE Coastal Trends	The Scientist-Educator Partnership Program	Enhances scientists' communication skills. Helps scientists meet their broader impact expectations, often for multi-investigator programs. Scientists/graduate students publish in education journals.
COSEE Great Lakes	Shipboard and Shoreline Science	Opportunities to teach about science in general, science as a career, and their own topic of interest; chances to see how their research could fit in classrooms and informal settings; outreach opportunities in general; funding for conferences.
COSEE New England	Summer Science in New England	Learning about informal education; connections to the Census of Marine Life and Encyclopedia of Life; Stipend (\$150/day x 5 days)
COSEE Networked Ocean World	Marine Activities Resources & Education (MARE) training	Science content - understanding of what scientists do and who they are - what interests them, how they think
COSEE Ocean Learning Communities	Addressing Broader Impacts Requirements workshop	This program targets scientists and has the goal of helping scientists develop further capacity in the area of E&O.
COSEE Ocean Systems	Scientist-Educator Collaborative (SEC) workshops & Research-based Online Learning Event (ROLE) model webinars	Better understanding of importance of putting their research into "big picture" contexts, avoiding jargon, and having a clear "take home" message. Direct interaction with educators helps them appreciate the challenges of pre-college and/or informal education. They find that concept mapping is a flexible tool that can be used for

		many purposes, including student evaluation.
COSEE Pacific Partnerships	Community College Faculty Workshops	Opportunities for broader impacts; understanding of the community college environment - many of their students will have this background.
COSEE SouthEast	Sea Seekers: Students and Scientist in the field	Scientists were able to experience both middle school students and their ability to understand the science and do investigations within their classroom settings and also to work with a very smart group of black undergraduates in science.
COSEE West	Online workshops	Scientists are able to interact more with educators; learn about presenting research to educators; learn how educators present this content to their students; more likely to work with educators on future science projects.

Table 6: How scientists are retained as part of the program and/or COSEE community

Center	Scientist Engagement Program	Scientist Retention Strategies
COSEE Alaska	Communicating Ocean Science Workshop at the Alaska Marine Science Symposium	Repeat participants; listserv; some joined SEANET social networking site; keep offering workshop due to popular demand from repeat scientists; some scientists strengthen relationships with educators
COSEE California	Communicating Ocean Sciences College Courses; Communicating Ocean Sciences Instructors Workshops	Nearly every scientist who has taught the course has taught it more than twice, many have taught it now 6 or 7 times. In addition, many scientists who taught the course became involved in the Ocean Literacy Campaign, the Ocean Sciences Curriculum Sequences or other E/O efforts.
COSEE Central Gulf of Mexico	Summer Teacher/Scientist Institute	The COSEE CGOM Management Team sends our quarterly, electronic newsletter to all former educator/scientist participants. All reports, presentations, and lesson plans are located on our website, i.e., < <a href="http://www.cosee-central-gom.org">www.cosee-central-gom.org</a> >.
COSEE Coastal Trends	The Scientist-Educator Partnership Program	All participating scientists have remained a part of our COSEE and have continued to present in our workshops.
COSEE Great Lakes	Shipboard and Shoreline Science	Primarily through newsletters and emails; 4/year serve on the Advisory Committee; Participation in COSEE research on scientist engagement and Center impacts
COSEE New England	Summer Science in New England	We have invited them to join NEOSEC as institutional representatives, engaging them for potential additional programming.
COSEE Networked Ocean World	Marine Activities Resources & Education (MARE) training	We tell them about the outcomes of their work and motivate them to continue to serve. Recognize them whenever and wherever we can.
COSEE Ocean Learning Communities	Addressing Broader Impacts Requirements workshop	Scientists continue to be invited to ongoing COSEE-OLC events; COSEE-OLC is planning additional capacity building workshops for scientists; COSEE-OLC provides one-on-one consultation to support scientists E&O efforts and outreach components of research proposals.
COSEE Ocean Systems	Scientist-Educator Collaborative (SEC) workshops & Research-based	In addition to the ROLE webinars (described above), COSEE-OS uses a blog as an additional mode of communication. Topically focused by concept maps, blogs serve as a forum for scalable content delivery.

	Online Learning Event (ROLE) model webinars	Blogs are another point of contact and allow educators further asynchronous access to scientists.
COSEE Pacific Partnerships	Community College Faculty Workshops	Asked if they will participate in other COSEE-PP activities, offered help with broader impacts of grant proposals
COSEE SouthEast	Sea Seekers: Students and Scientist in the field	These scientists continually work with COSEE SE and SC Marine Education Association in providing space and their own time.
COSEE West	Online workshops	Center staff continues to maintain contact with scientists that have participated in COSEE-West and to identify opportunities for future education outreach. Scientists also approach Center staff for assistance on their broader impacts or education outreach programs of their proposals.

Table 7: How Centers Evaluate the Engagement of Scientists

Center	Evaluation Strategies
COSEE Alaska	Surveys
COSEE California	COSEE-funded evaluation has been minimal, documenting the numbers of students and scientists involved and the quality and effectiveness of the program. Two larger NSF ISE grants (COSIA and COSIA Network) have supported larger evaluation studies that have looked at the development of partnerships and the impact of the program on students, scientists and IHEs.
COSEE Central Gulf of Mexico	The COSEE CGOM External Evaluator has been interviewing our scientists for the last three years. These findings are listed in our Annual Reports on our website, < <a href="http://www.cosee-central-gom.org">www.cosee-central-gom.org</a> >.
COSEE Coastal Trends	Interviews
COSEE Great Lakes	Evaluator follows workshops with immediate and long-term [6 months to 2 years later]; impact surveys that include both general engagement/collaboration questions and items specific to the event in which the scientists participated
COSEE New England	External evaluation through in-person and written surveys
COSEE Networked Ocean World	Formative surveys and personal communication
COSEE Ocean Learning Communities	Interviews with participating scientists; surveys of participating scientists; tracking of scientists participation in COSEE-OLC events and other interactions with COSEE-OLC. support scientists' E&O efforts and outreach components of research proposals.
COSEE Ocean Systems	Online surveys and phone interviews by external evaluator Dr. Ted Repa
COSEE Pacific Partnerships	Post event surveys; conversations with scientists
COSEE SouthEast	We have consulting evaluators who interview the scientists and provide reports within the scope of the project. COSEE SE educators talk with scientists
COSEE West	Scientists are surveyed after the online workshop and at the end of the program year regarding their participation in the online workshop and in COSEE-West in general. Interactions between scientists and educators in the online workshop environment are also reviewed. In the Moorea online workshops, scientists and their students conducting field research in Moorea and students presenting their results at UCLA were also observed.

Table 8: Brief Summary of Evaluation Results

Center	Evaluation Results
COSEE Alaska	Communicating Ocean Science Evaluation Reports 2009 and 2010 reports prior knowledge, usefulness, the likelihood of using the model or incorporating the knowledge and interest.
COSEE California	<p>A full technical final evaluation report, which includes three case studies, is available on the Inverness Research website at:  <a href="http://www.inverness-research.org/abstracts/ab2010-06_Rpt-COSIA-final-eval-rpt.html">http://www.inverness-research.org/abstracts/ab2010-06_Rpt-COSIA-final-eval-rpt.html</a></p> <p>This evaluation report includes:</p> <ul style="list-style-type: none"> <li>--Benefits to Educators including Informal Science Education Institution Educators and University Scientist Educators</li> <li>--Benefits to Institutions including Informal Science Education Institutions and Institutions of Higher Education</li> <li>--Benefits to Both Partner Institutions including 1) Additional funding for new programs and projects, 2) Institutionalization of the work, and Increased capacity to partner in the future</li> </ul>
COSEE Central Gulf of Mexico	The COSEE CGOM PI and Co-Investigators have not experienced nearly the difficulties in 2006-2010 award as we encountered in 2003-2005 award in recruiting scientists for the multi-day face to face and the online components of the Summer Institutes or the Two-Day Workshops for multiple days of involvement, not just 2-3 hours. Scientists have a greater appreciation for "what teachers do" on a daily bases; they are more aware of the importance of standards and testing; they have a better understanding of the manner in which pre-college students and the public need to have research relevance based on the analogy...."so why should I be interested in these findings and what do they do for me?" And, the scientists have documented they enjoy working with our formal and informal educators.
COSEE Coastal Trends	Scientists find the program a great benefit to themselves and to their graduate students.
COSEE Great Lakes	This is in preparation for our Education Summit that will be going on at the same time as the Broader Impacts meeting. Will get a copy to you when it becomes available. Enough reporting for our final year!
COSEE New England	<p>Our Final Evaluation Study for COSEE NE (April 2010) includes results of an Impact Study of the Center's programming; 49 scientists took part. Close to three-quarters or more of the scientists who responded to the survey rated the COSEE-NE programs as either 'excellent' or a 'good start' on the following attributes. Scientists said the programs:</p> <ul style="list-style-type: none"> <li>• Improved OS researchers' skills in working effectively with educators [86%]</li> <li>• Expanded OS researchers' opportunities to contribute to OS education [81%]</li> <li>• Provided opportunities for educator/OS researchers to work together [78%]</li> <li>• Deepened OS researchers' knowledge of science education [76%]</li> <li>• Supported educator/OS researcher collaborations [73%]</li> </ul>
COSEE Networked Ocean World	Not sure how to represent this - we have lots of reports you can access. Basically we use formative questions to assess their level of engagement in working with teachers and to ask what they see as the value to their work with us.
COSEE Ocean Learning Communities	Evaluation reports indicate that scientists are benefiting from the activities of COSEE-OLC. For example, a key finding from the survey results from the workshop described above was that "Scientists found the event to be useful professional development and 98% of respondents would welcome another similar activity. Survey data show that scientists who have participated in COSEE-OLC events are actively involved in a wide range of education and outreach."
COSEE Ocean Systems	COSEE-OS efforts towards capacity building may have contributed to the high

	level of participation by OS researchers (81%; n=25) in the 2009 Network-wide survey of scientists who had participated in COSEE activities during 2009. 32% of these scientists had been involved with COSEE-OS as "resource providers" and 20% as "advocates" or "advisors" to OS, while the vast majority (92%) were involved as "participants" in OS programs and activities. Most of the survey respondents identified their field as "Oceanography" (80%). Other well-represented fields included "Aquatic Science" (52%), "Marine Biology" (48%), and "Earth Science" (30%). Of these scientists, 72% stated that OS online tools have been "Useful" to "Very Useful" in their efforts and 88% stated that they are "satisfied" to "very satisfied" with COSEE-OS assistance. Most were either in an early (44%) or mid-career (40%) stage of their profession, and a slight majority receive NSF funding for their research (52%). 80% receive greater than 50% of their funding from federal sources (NSF = 36% and "other federal agency" = 44%). The majority of these scientists also work as "teachers, educators, or instructors" (80%) in a "formal education setting" (76%) such as "college" (80%), where most are not tenured (60%).
COSEE Pacific Partnerships	Surveys and conversations indicate that scientists find the CC faculty and student programs meaningful and valuable for transferring content. All will willingly participate again and express strong satisfaction with their experience. Our participation with COSEE - OS was well received by scientists, and we will do longer term evaluation to see how they implement plans.
COSEE SouthEast	We do not have a model of scientist engagement in the past award. However we have a model for the 2010-2013 award.
COSEE West	Overall scientists were quite engaged during the online workshops, particularly those involving student field research. Scientists also gained additional insight on presenting their research and making it more applicable to formal/informal settings.

Table 9: Major benefits and weaknesses of Center programs engaging ocean scientists

Center	Benefits and Weaknesses
COSEE Alaska	One great strength of our program is the opportunity to reach more than 700 ocean scientists gathered annual in Anchorage with opportunities for workshops and luncheon activities and speakers focused on broader impacts. Workshops feature scientists sharing with scientists and educators and bringing in traditional knowledge practitioners and culturally responsive outreach models.
COSEE California	We have focused on engaging scientists in strategic Broader Impact activities, i.e., they are scalable activities that create opportunities for other scientists to become involved with less effort (e.g., development of a college course); or they are activities that are high level and will have significant regional and/or national impact (Ocean Literacy Campaign). We don't to very much of placing a scientist into a "one-off" education program as a speaker or resource.
COSEE Central Gulf of Mexico	The major benefit has been COSEE CGOM serving as a catalyst in enhancing the engagement among scientists and educators (formal and informal) in affirming the paradigm shift that has occurred and is occurring between these two groups of professional in their disciplines. This long-term benefit is a "win-win" for everyone involved, i.e., NSF-Geosciences Directorate, Ocean Sciences Division; the educators; the scientists; and the positive impact the educators' increased content knowledge (through their engagement with the scientists) is having on an increased environmental and ocean literate population of pre-college students and public. And, the scientists are sharing the relevance of their ocean, coastal, and watershed findings for broader societal impacts. Our greatest weaknesses have been in not recruiting as many

	underrepresented participants as desired and not adding more "refined" lesson plans to our COSEE CGOM website as resources for educators' use.
COSEE Coastal Trends	Time commitment is the major drawback. However, all scientists so far have said it is worth the time and effort.
COSEE Great Lakes	To be included in our evaluator's report. From an administrative perspective, the benefits are increased science support for education efforts, and participant/staff learning/updates in the sciences. Weaknesses are based primarily in our level of follow-up; we have not engaged many of the scientists beyond their workshop participation. For smaller numbers [20-30] we have continued interaction over several years.
COSEE New England	Strengths: High expectations of participation by scientists in multiple aspects of the programs; facilitated partnerships with local educators and educational institutions; effective incorporation of science into educational materials that help scientist-participant feel that their contribution is taken seriously. Weakness: Lack of sufficient staff resources to provide sustained engagement of and support to individual scientist-participants following on face-to-face contact.
COSEE Networked Ocean World	Very hard to scale this work. I can only work closely with so many at this intensive level. We are working on getting staff at Liberty Science Center to be able to "work with" scientists at this level. So far so good.
COSEE Ocean Learning Communities	Major benefits: -Support scientists in developing their own capacity for doing education and outreach. -Scientists choose the type of outreach they are most interested in and we support them in doing that kind of outreach (K-12 education/informal education/lectures to non-scientists adult audiences, interactions with the media, etc.) -We provide exposure to various types of outreach so scientists can see them in practice before committing to participating, reducing the novelty of some outreach activities they may not have experienced previously. Weakness/challenge -Scientists are eager to learn more about doing E&O, but likely benefit the most from regular exposure to capacity building workshops. It is important to have regular programming.
COSEE Ocean Systems	Major benefits: Flexibility, transferability, scalability Major weaknesses: Not-yet-proven ability to sustain scientist-educator relationships, lack of focus on demonstrating scientists' impacts on education (both thing we're working on in the renewal cycle)
COSEE Pacific Partnerships	Weaknesses - scientists do not always get the level that community college STUDENTS need for curriculum, however most community college FACULTY who attend the workshops appreciate receiving information that is complete and sometimes complex and they have the ability to translate to their curriculum. In the ideal world we would have the scientists practice and undertake a review of their materials prior to all of our activities. In the real world this would never happen for tier 1 University scientists who we are trying to engage. They would not make the time to have this happen. The strength are that we are using these top notch scientists to engage with the CC faculty so we are presenting NEW science - not what they get in the text book.
COSEE SouthEast	We have a large region with many Tier One universities and marine laboratory. The weakness is that we are a small staff and travel is an issue. We have over 480 scientists on our database and contact them via email. Benefit: our Board of Advisors consists of key ocean scientists from the 3 states and they provide input relative needs of scientists. Benefit: we use thematic approaches in PD and thus we have a credible outreach opportunity for selected scientists who want to be engaged. Weakness: we don't deal with some of the NSF scientists at

	this point.
COSEE West	Online workshops are a great way to engage scientists in presenting their research and interacting with educators over a more sustained period of time. These scientists also participate in future program activities and seek input on their broader impacts or education outreach programs. Online dissemination makes it easy for scientists to participate regardless of their location or time commitments. Online dissemination also makes it easier to conduct workshops for small or large audiences and to do topics of more general interest or ones that are specialized.

Table 10: How Scientists describe their COSEE broader impact experience

Center	Scientist Descriptions
COSEE Alaska	The chance to share with and learn from other scientists and engage with educators; to explore opportunities; valuable resources are shared.
COSEE California	Scientists interviewed for our evaluation studies say that COSEE CA: makes it easy for them to participate, helps them to do things they already want to do but can't or don't have time for, always delivers high quality, makes good use of their time and takes best advantage of their skills.
COSEE Central Gulf of Mexico	The interviews conducted by the COSEE CGOM External Evaluator are documenting the value of engagement by the scientists...which for our Management Team is tremendously good news. These types of findings should also strengthen the COSEE Decadal Review Process for NSF.
COSEE Coastal Trends	Team approach
COSEE Great Lakes	To come in evaluator's report.
COSEE New England	Responses are positive -- they especially appreciate the opportunity to learn from their educator-counterparts.
COSEE Networked Ocean World	They appreciate it and feel like they are providing a service.
COSEE Ocean Learning Communities	Scientists describe their experiences in our programs as being positive and inspiring. COSEE-OLC makes a conscious effort to meet scientists' needs in our programs. We survey scientists to determine what their needs are in the area of E&O, and build programming to support those needs. When we engage scientists in events aimed at a more public audience we work to ensure that scientists de-brief with our evaluator. The debriefing process provides COSEE-OLC with useful information about scientists needs/wants, and provides an opportunity for scientists to reflect on their experience and to interact with other scientists actively engaging in E&O.
COSEE Ocean Systems	They are invigorated by getting feedback on how to craft their messages for various audiences. They also note that having a flexible delivery mechanism (i.e., concept mapping both "on paper" and using COSEE-OS online tools) helps them with planning and teaching college-level courses.
COSEE Pacific Partnerships	So far all have been positive about their participation and readily willing to continue. Elements that are important are upfront work in preparation done by our center for logistics, planning of activities, and information in audiences. Follow up work to make their materials available to participants. We are getting increasing requests for support planning and letters for broader impacts of grants.
COSEE SouthEast	We have a lot of interview quotes in annual reports that state they like working with COSEE SE, feel their time is valued and they are willing to review materials.
COSEE West	Scientists feel that the quality of interactions with educators is high and that it enables them to learn from the questions posed by educators on how to present and adapt their research to educators and the general public. Scientists also greatly enjoyed presenting their research to educators that were so interested in



	learning more about that topic.
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## Appendix C

### References Used to Design and Implement COSEE Center Scientist Engagement Programs

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